EXHIBIT 2

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

SECURITIES AND EXCHANGE COMMISSION, **Plaintiff,** **vs.** **LEK SECURITIES CORPORATION,** **SAMUEL LEK,** **VALI MANAGEMENT PARTNERS dba AVALON FA LTD,** **NATHAN FAYYER, and** **SERGEY PUSTELNIK a/k/a SERGE PUSTELNIK,** **Defendants**.	Case No. 17-CV-1789

EXPERT REPORT OF TERRENCE HENDERSHOTT, PH.D.
APRIL 3, 2017

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List of Exhibits and Appendix

I. INTRODUCTION

A. Qualifications

1. My name is Terrence Hendershott. I am a Professor at the Haas School of Business at the University of California, Berkeley, where I hold the Cheryl and Christian Valentine Chair. I received my Ph.D. from the Graduate School of Business at Stanford University. A detailed listing of my educational background and publications is set forth in my curriculum vitae, which is attached as Exhibit 1. The curriculum vitae includes my publications over the last 10 years and the cases in which I testified as an expert witness since 2010.

Exhibit 1. Curriculum Vitae of Terrence Hendershott, Ph.D.

2. My expertise and research interests focus on market microstructure. This includes the role of information technology in financial markets, electronic communications networks and financial market design, regulation of financial markets, and algorithmic and high-frequency trading. I have published numerous articles on market microstructure that examine the impact of information technology on financial markets, the structure and regulation of financial markets, how information is incorporated into security prices, market making, and algorithmic and high-frequency trading in leading economics and finance journals, including Journal of Finance, Journal of Financial Economics, Review of Financial Studies, and Review of Economic Studies. My research on incorporating information into security prices and algorithmic and high-frequency trading focuses on what information traders use, how their strategies interact, and how these affect prices. Issues regarding how traders react to different types of information are fundamental to understanding possible manipulation in modern electronic financial markets. I have received awards from the Western Finance Association, the Financial Management Association, and the Society for Financial Studies for

my research on electronic trading and algorithmic trading. I received a CAREER grant from the National Science Foundation for studying electronic trading systems in financial markets. CAREER grants are the National Science Foundation's most prestigious awards in support of early career-development activities.

3. I teach undergraduate- and graduate-level courses at the Haas School of Business on high-frequency finance, operations management, and information technology strategy. I teach master of financial engineering students about market structure, market making, trading strategies, and market manipulation. I serve on the editorial boards of leading finance and operations management journals, such as Management Science, Journal of Financial Markets, and Decision Support Systems.

4. In addition to my academic work, I have served as the visiting economist at the New York Stock Exchange from 2005 to 2006, as a member of the NASDAQ Economic Advisory Board from 2004 to 2007, and as chair of the NASDAQ Economic Advisory Board in 2007. I am a member of the Financial Industry Regulatory Authority's (FINRA) market surveillance advisory group. I have also consulted on issues related to market making and how trading impacts prices for a number of exchanges, high-frequency trading firms, and investment firms.

5. I am being compensated at the rate of $600 per hour for my work in this matter. My compensation is not contingent upon the outcome of this matter.

B. Materials Considered

6. The facts and data that I considered in forming the opinions expressed in this report are listed in Exhibit 2.

Exhibit 2. Facts and Data Considered

7. My opinions are also based upon my own educational and professional experience and background, including those listed under my qualifications and in my curriculum vitae.

C. Summary of Assignment

8. I have been asked by the Securities and Exchange Commission ("SEC") to review Avalon FA Ltd.'s ("Avalon") transaction data[1] for the common stock of various companies traded on U.S. markets through Lek Securities Corporation ("Lek") during the period of December 2010[2] through September 2016 (the "Avalon Trade Data"). Specifically, for purposes of this report, I have been asked to provide opinions as to the following:

a. Whether any of Avalon's order and trade activity is consistent with manipulative behavior often called "spoofing" or "layering"; and

b. To quantify the amount of trading revenue, if any, that resulted from the activity identified under (a).

9. To accomplish the above, I directed a forensic examination of data and records including the Avalon Trade Data and market data (see Exhibit 2).

10. I have also been asked to offer my opinions as to whether layering or spoofing is harmful to the securities markets and market participants.

D. Summary of Opinions

11. A summary of my opinions is as follows:

a. Limit orders influence other market participants' trading behavior, which impact prices. As such, manipulative strategies such as layering or spoofing

[1] Including trade and order data related to orders, purchases, and sales.

[2] I also examine data from November 2010, but there is no relevant trading activity that month.

can exist whereby traders place limit orders on one side of the market without intending for those orders to execute, in an attempt to mislead other market participants with respect to the supply and demand for that security, thereby affecting the price for that security in order to obtain better execution of orders on the other side of the market.

b. After analyzing the Avalon Trade Data, I find that Avalon's order and execution activity is frequently consistent with layering. Specifically, there are 675,506 instances consistent with layering over the period from December 2010 to September 2016.

c. I conduct a series of further analyses to confirm that the instances identified in (b): (i) have characteristics indicative of a layering strategy that misleads market participants to achieve more favorable executions, and (ii) that such characteristics are unlikely to arise unintentionally or as part of a non-layering trading strategy that places orders on both sides of the market, such as market making.

d. Avalon earned substantial trading revenue through the above trading. Specifically, trading revenue from trading consistent with layering totaled more than $21 million, of which $12 million was earned in 2015 and 2016 alone. Further, trading consistent with layering accounted for more than 45% of Avalon's trading revenue, even though it made up less than 5% of Avalon's trading volume.

e. Layering can harm the markets for the following reasons: (i) layering can create uncertainty and decrease market liquidity, (ii) layering can increase

the difficulty of executing orders, and (iii) layering can degrade market integrity and reduce market participation.

II. BACKGROUND

A. Modern Financial Markets and the Impact of Limit Orders

12. Modern financial markets typically operate as an open electronic limit-order book. Limit orders are instructions to trade at a price that is no worse than the limit price specified by the trader.[3] Information about pending (not yet executed) limit orders is typically available to market participants. Market participants use such data to understand supply and demand in the market to improve the execution of their orders by receiving faster execution at better prices for larger quantities.[4] Information on pending orders also helps forecast future actions of other market participants that can be incorporated in trading strategies.[5] Traders can choose to have their limit orders be visible to other traders or have their orders hidden. Visible orders impact market participants' perception of supply and demand, while pending hidden orders do not.

[3] For example, a limit order to purchase at $5 per share will be executed at $5 or less, while a limit order to sell at $5 per share will be executed at $5 or more.

[4] Limit orders are informative to traders because they are predictive of future price movements, see, e.g., Bruce Mizrach, "The next tick on Nasdaq," *Quantitative Finance* 8 (2008): 33, Charles Cao, Oliver Hansch and Xiaoxin Wang, "The Information Content of An Open Limit-Order Book," *Journal of Futures Markets* 29 (2009): 34, and Michael J. Fleming, Bruce Mizrach and Giang Nguyen, "The Microstructure of a U.S. Treasury ECN: The BrokerTec Platform," *Journal of Financial Markets* (forthcoming): 3. Limit orders can directly impact trade prices even if the orders are placed at prices inferior to the best bid and offer prices, see Nikolaus Hautsch and Ruihong Huang, "The market impact of a limit order" *Journal of Economic Dynamics & Control* 36 (2012): 513. Market participants relying on market data about supply and demand include market makers, high-frequency traders, and investors using algorithms to implement their trading strategies, such as mutual funds, pension funds, and other institutional investors.

[5] Terrence Hendershott and Ryan Riordan, "Algorithmic Trading and the Market for Liquidity," *Journal of Financial and Quantitative Analysis* 48 (2013): 1016.

B. Layering

13. Strategies often referred to as "spoofing" or "layering"[6] typically involve certain traders placing visible limit orders (on shares of a company's common stock, for example) that they do not intend to execute, but rather to create an artificial appearance of supply or demand to improve the execution of their other orders.[7] Layering involves placing orders on both the buy and sell sides of the market. Limit orders on one side of the market are entered without the intent of executing in order to benefit the orders on the other side that are intended to execute. Once the desired execution occurs, the remaining orders are cancelled. Similar to how a shill bidder enters fake bids to induce other bidders in an auction to bid higher, layering traders can induce other traders to improve the prices on their orders. For example, a trader attempting this strategy might place many visible purchase (or sale) orders to create the artificial appearance of demand (or supply) to mislead other market participants into believing a company's stock price should be higher (or lower). These higher (lower) prices would then improve the execution of the trader's opposite side orders.

14. A successful layering strategy will benefit a trader by selling shares at higher prices,[8] or buying shares at lower prices, through misleading the market about supply or demand. This is typically done by placing orders on the two sides of the market in an imbalanced manner, e.g., there are more buy orders than sell orders with the trader generally

[6] Layering is often used to refer to spoofing when multiple spoofing orders are used. Because the trading activity at issue here involves multiple orders I will use layering throughout.

[7] Douglas Cumming, Sofia Johan, and Dan Li, "Exchange trading rules and stock market liquidity," *Journal of Financial Economics* 99 (2011): 654.

[8] Note that the layering traders can improve the execution of their sale orders in several possible ways. When the layering trader's sale orders are marketable, i.e., the orders execute immediately, they benefit from executing against a higher bid price or in larger quantities. When the layering trader's sale orders are non-marketable limit orders, i.e., pending limit orders that do not execute immediately, they benefit from an increased chance of execution at a better price or in larger quantities. The layering trader's buy orders' execution can be improved in a similar manner.

not intending to execute orders on the buy side. Accordingly, the side with more orders for a greater quantity of shares placed by the trader to create the artificial appearance of supply or demand is referred to as the **"Loud"** side. The smaller side of the strategy that the trader intends to benefit from is referred to as the **"Quiet"** side. The intended effect of the Loud-side orders is to mislead market participants in the desired direction, so the quantity of orders and desired execution rate of these orders will typically be **"Imbalanced"** relative to the Quiet-side orders.[9] In fact, a well-implemented layering strategy results in Quiet-side shares executing more frequently than Loud-side shares.

15. Below, I outline my methodologies for evaluating whether Avalon Trade Data shows conduct consistent with layering.

III. ANALYSIS AND OPINIONS

A. Identifying Layering Loops

16. The Avalon Trade Data is comprised of orders, cancellations, and executions made by Avalon traders from November 2010 through September 2016. The data also includes information indicating the trader that placed an order, the exchange through which the order was routed, price,[10] symbol, quantity,[11] instruction,[12] date, and time.

[9] In layering the Loud-side orders are characterized as non-bona fide because the layering trader does not intend those orders to execute. The Quiet-side orders are bona fide as the layering trader intends those orders to execute. Consequently, the quantity of Loud-side orders is much higher than Quiet-side orders, while the execution rate of Loud-side orders is much lower than Quiet-side orders.

[10] Price data includes the type of order placed, including limit orders, market orders, market on open orders, etc.

[11] The quantities in the Avalon Trade Data include the quantity ordered, the quantity made visible to other market participants, the quantity cancelled, and the quantity executed.

[12] Instruction includes whether an order is a purchase, sale or cancellation order, and whether a trade is a purchase or sale execution.

17. The first step in my analysis is to establish a set of criteria to analyze the Avalon Trade Data, and identify instances in which certain Avalon traders' behavior is consistent with a layering strategy. For the purposes of this report, I rely on three criteria to identify orders and trades consistent with layering: that traders place both purchase and sale orders in a single stock before closing these orders out through cancellation or execution (which I will define as a **"Loop"**), that the Loud-side orders be sufficiently greater than the Quiet-side orders (sufficient **"Order Imbalance"**), and that the execution of any Quiet-side orders be sufficiently greater than the Loud-side orders (sufficient **"Execution Imbalance"**). If the three criteria are met, I define the identified Loops as **"Layering Loops."**

18. First, I conservatively limit my analysis to identifying instances in which traders place both purchase and sale orders in a single stock before executing or cancelling these orders within 60 seconds.[13] Of course, initiating and closing a group of purchase and sale orders within 60 seconds can potentially represent a legitimate high frequency trading strategy. Therefore, after identifying these 60-second "Loops," I examine each Loop more closely to determine whether the order and transaction patterns are consistent with layering, as follows.

19. Second, I require each Loop to have sufficient Order Imbalance. A layering strategy involves a trader attempting to use Loud-side orders to mislead other market participants to benefit the layering trader's Quiet-side transactions. Therefore, a Layering Loop typically involves more Loud-side orders than Quiet-side orders. For the purposes of this report, I require the ratio of Loud-side orders to Quiet-side orders (both with respect to the

[13] This is conservative as it is certainly possible for traders to engage in a layering scheme for a set of purchase and sale orders and transactions that last longer than 60 seconds.

number of orders, and the number of shares in those orders) to be at least 2-to-1 for Layering Loops.[14]

20. Third, having established that a Layering Loop must last 60 seconds or less, and must have sufficient Order Imbalance, I also require it to have a sufficient Execution Imbalance. That is, a successfully implemented layering strategy must involve Loud-side shares being executed less often than Quiet-side shares, even though Loud-side shares are more numerous.[15] For example, if the trader is attempting to use Loud-side purchase orders to mislead market participants (to benefit from a Quiet-side sale), executing those Loud-side orders as often as Quiet-side orders diminishes or eliminates layering-related benefits.[16] For the purposes of this report, I require the ratio of executed Quiet-side shares to executed Loud-side shares to be at least 3-to-1 for Layering Loops.

21. Using the three steps defined above, there are approximately 2 million 60-second Loops with Order Imbalances greater than or equal to 2-to-1 in the Avalon Trade Data between December 2010 and September 2016. Of these, 675,506 qualify as Layering Loops, as there are at least three times as many Quiet-side shares executed relative to Loud-side shares.[17] This means that Quiet-side orders execute at more than 6 times the rate of Loud-side orders in

[14] Some exchanges allow for hidden orders which are not visible to other traders. Because only displayed orders impact observed supply and demand, only displayed orders are used when determining Order Imbalance. Because Loops with smaller numbers of orders are more difficult to characterize, in this report, I omit Loops with only 3 orders or less.

[15] Examining only Loops with Execution Imbalance also eliminates trading strategies such as market making that place similar orders on both sides of the market or have imbalanced order submissions where the Loud-side orders and Quiet-side orders execute similarly or the Loud-side orders execute more frequently. Additionally, I require that no Loud-side orders be placed more than one second after the last Quiet-side execution or cancellation in Layering Loops, as a layering strategy typically involves using Loud-side orders to achieve favorable execution for Quiet-side orders.

[16] Although traders will try to minimize the number of Loud-side orders that execute, infrequent Loud-side order executions may occur.

[17] The electronic file labeled Appendix A contains summary information identifying each of the Layering Loops. The details of each Layering Loop are contained in the Avalon Trade Data.

Layering Loops. The Order and Execution Imbalances are consistent with layering and highly unlikely to occur by chance.[18]

Appendix A. Summary of Layering Loops

B. Further Analyses of Layering Loops

22. I perform additional analyses to evaluate: (i) whether the Layering Loops I identify in Section III.A have characteristics indicative of a layering strategy that misleads market participants to achieve more favorable executions, and (ii) whether such characteristics are likely to arise unintentionally or as part of a non-layering trading strategy that places orders on both sides of the market, such as market making.

1. Cancellation Analysis: Loud-side Orders Are Quickly Cancelled Following Quiet-side Executions or Cancellations

23. First, I examine how quickly Loud-side orders are cancelled following the final Quiet-side execution or cancellation.[19] If Order and Execution Imbalances arise unintentionally, then there is no reason to cancel Loud-side orders quickly after the execution or cancellation of Quiet-side orders. Conversely, once the Quiet-side orders are executed or are cancelled, a layering strategy would attempt to cancel Loud-side orders quickly to avoid execution of these transactions. Therefore, I examine the Layering Loops to determine how frequently Loud-side orders are quickly cancelled after the Quiet-side orders are eliminated. Exhibit 3 shows that in 85% of Layering Loops, all pending Loud-side orders are cancelled

[18] In Order-Imbalance Loops, the Quiet-side shares execute at almost 5 times the rate of Loud-side shares: approximately 63% of Quiet-side shares execute, while less than 13% of Loud-side shares execute. The standard statistical test for whether averages in two samples are reliably different from one another is a difference in means test. Applying this test to the differential execution rates for Loud-side and Quiet-side execution rates in Order-Imbalance Loops reveals that these rates would occur by chance less than 0.01% of the time.

[19] The Execution Imbalance criterion requires that at least some of the Quiet-side shares execute, and that they execute at least three times as often as the Loud-side shares.

within 3 seconds of the final Quiet-side execution or cancellation, and in 90% of Layering Loops, cancellation occurs within 4 seconds. This result is consistent with a layering strategy which tries to minimize the execution rate of Loud-side orders.

Exhibit 3. Cancellation Analysis: Time from Last Quiet-side Execution/Cancellation to All Loud-side Cancellations (Cumulative Percent of Layering Loops)

2. Position Analysis: Order Imbalances in Layering Loops Are Inconsistent with Attempting to Reduce Positions in a Given Equity

24. Second, I examine how the Order Imbalances in the Layering Loops are consistent with attempting to reduce positions in a given equity. Traders at Avalon hold overnight shares less than 0.5% of the time. Traders with short holding periods manage risk by trading in the opposite direction of any long or short position they have at the start of a Loop. Market makers also manage their risk by placing orders to reduce their position.[20] A typical way to do this is by placing more orders in the desired direction of trade – for example, a trader that is long in a certain equity will place more orders on the sell side to reduce that long position, while a trader that is short will place more orders on the buy side to cover that short position. In contrast, a layering strategy will do the opposite. Because Loud-side orders are used to mislead market participants to achieve more favorable Quiet-side executions, a layering strategy will place more orders on the Loud-side (in which there is already a position) to execute more favorably on the Quiet-side. For example, if traders engaging in a layering strategy are long, the traders will typically place a large number of Loud-side buy orders to mislead market participants into believing demand for the stock is higher, and then execute Quiet-side sell orders to reduce their holdings. In contrast, a market maker with a long position

[20] Yakov Amihud and Haim Mendelson, "Dealership market: Market-making with inventory," *Journal of Financial Economics* 8 (1980): 34,44.

will typically place more sell orders, and also be more likely to execute those sell orders. Therefore, I examine the traders' positions at the start of Layering Loops and the direction of Loud-side orders to determine if the low Loud-side execution rates appear to be unintentional (or consistent with market making).

25. Comparing Avalon's traders' positions at the start of Layering Loops with the direction of Loud-side orders, I find that when Layering Loops have a starting position in the equity (whether long or short), the direction of the position is consistent with layering more than 88% of the time. Specifically, I find that when a trader's position is long at the beginning of a Layering Loop, the buy side is the Loud-side 88% of the time, and when a trader is short at the beginning of the Layering Loop, the sell side is the Loud-side 89% of the time. Exhibit 4 summarizes the results of my findings. This result suggests that Order and Execution Imbalances do not arise unintentionally and are not consistent with market making, but are consistent with a layering strategy.

Exhibit 4. Position Analysis: Starting Position Relative to Loud-side Orders

3. NBBO Movement Analysis: Price Movements During Layering Loops Are Frequently Favorable Towards Quiet-Side Orders

26. Third, I examine a subset of Avalon's Layering Loops to confirm the academic literature's consensus that imbalances in limit orders can affect prices. In particular, I analyze the movement of National Best Bid and Offer ("NBBO") prices[21] during Avalon's Layering Loops.[22] The subset includes approximately 87,000 Layering Loops.

[21] I use the NBBO midpoint, which is the average of the best bid and offer prices.

[22] The SEC requested that I perform this analysis using data from Avalon sub-account 188 during the period from August 2012-December 2012, sub-account 208 from April 2013-September 2013, and sub-account 128 from March 2015-August 2015. A small part of this Avalon data did not have corresponding NBBO data in Wharton Research Data Services and is, therefore, not included in the NBBO analyses.

27. Traders engaged in a layering strategy seek to influence the market in order to execute their Quiet-side orders at more favorable prices. Therefore, I evaluate how often the stock price rises when the Loud-side is the buy side and how often the stock price falls when the Loud-side is the sell side. In a Layering Loop in which the Loud-side orders are purchase orders, the NBBO midpoint being higher at the time of Quiet-side sale executions than it is when the Layering Loop starts is consistent with a trader's Loud-side buy orders impacting the price. Conversely, when Loud-side orders are sale orders, the NBBO midpoint being lower during Quiet-side purchase executions than it is at the start of the Layering Loop is consistent with a trader's Loud-side sell orders impacting the price. Typically, over short-time intervals such as a minute or less, the average change in the NBBO midpoint is zero and prices should rise on average 50% of the time and fall on average 50% of the time.

28. In Layering Loops where Loud-side orders are purchases, Exhibit 5 shows that the NBBO midpoint at the time of Quiet-side sale executions is higher than at the start of the Loop 62% of the time. When Loud-side orders are sales, the NBBO midpoint is lower at the time of Quiet-side purchase executions than at the start of the Loop 64% of the time. These results are consistent with Avalon's Loud-side orders contributing to a favorable shift in the NBBO midpoint more often than would be expected by chance.

Exhibit 5. NBBO Movement Analysis: Price Movement Relative to Loud-side Orders

4. Realized Spread Analysis: Quiet-side Executions Are Much More Profitable than Loud-side Executions

29. Fourth, for all executions in the same subset of Layering Loops as in the preceding section, I examine the profitability of Avalon's Loud-side and Quiet-side executions by calculating a measure of profitability widely used in the academic literature, the "realized spread." The realized spread for each trade is the difference in execution price and the NBBO

midpoint 5 minutes in the future.[23] This is essentially a mark-to-market measure of trading revenues. Traders have positive realized spreads if they execute their buy orders at a lower price than the NBBO midpoint 5 minutes in the future, or if they execute their sell orders at a higher price than the NBBO midpoint 5 minutes in the future. Traders engaged in a layering strategy should have more positive realized spreads on their Quiet-side executions than on their Loud-side executions. Potentially, layering traders could have negative realized spreads on their Loud-side executions, as these are typically not intended to execute.

30. Exhibit 6 shows that Quiet-side executions in layering loops tend to have a positive realized spread when compared to the NBBO midpoint 5 minutes later, while Loud-side executions tend to have a small negative realized spread. The negative realized spread on Loud-side executions is not consistent with the Loud-side orders having an economic rationale on their own. The Loud-side executions are not profitable by themselves. The Quiet-side executions are profitable. This is consistent with Avalon impacting the market in order to execute its Quiet-side orders at a more favorable price than would have been available absent its Loud-side orders.

Exhibit 6. Realized Spread Analysis

31. In summary, the results regarding: (i) the cancellation analysis of Loud-side orders; (ii) the position analysis of traders' starting positions relative to the Loud and Quiet sides, (iii) the analysis of NBBO price movements relative to the Loud and Quiet sides, and (iv) the realized spread analysis for Loud-side and Quiet-side executions are all consistent with

[23] Realized spread is calculated as q * (NBBO midpoint five minutes after trade - execution price), where q is +1 for purchases and -1 for sales. See: Terrence Hendershott, Charles Jones, and Albert Menkveld, "Does Algorithmic Trading Improve Liquidity?" *Journal of Finance* 66 (2011): 11.

Avalon using Loud-side orders to potentially mislead market participants and achieve more favorable Quiet-side execution prices.

C. Examples of Layering Loops

1. Trading in Cerner Corporation on November 1, 2012

32. Exhibits 7a and 7b illustrate two consecutive Layering Loops identified in the Avalon Trade Data that involve trading in shares of Cerner Corporation ("CERN") on November 1, 2012. In the first Loop, the trader places multiple Loud-side purchase orders consistent with creating an artificial appearance of demand, thereby placing upward pressure on the stock price and allowing him to sell shares at an advantageous price. In the second Loop, the trader covers his short position by placing multiple Loud-side sale orders consistent with creating an artificial appearance of supply, thereby placing downward pressure on the stock price, and allowing him to buy back the shares at an advantageous price.

33. In Exhibit 7a, the trader begins the Loop with no outstanding orders or shares, and first places a sale limit order.[24] The trader then places multiple purchase orders in a short period of time.[25] These Loud-side purchase orders appear to have successfully placed upward pressure on the stock price. Shortly after the Loud-side purchase orders end, two Quiet-side sale orders execute, with the trader selling shares at a price higher than available before the Loop started.[26] The remaining Loud-side sale orders are then cancelled. In summary, the

[24] At around 12:50:40, the trader places a sale limit order for 1,000 shares at $77.15.

[25] Over the period from 12:50:42 to 12:50:48, the trader places 45 purchase limit orders for 100 shares each at increasingly higher prices from $77.11 to $77.14.

[26] Between 12:50:47 and 12:50:49, the first sale limit order for 1,000 shares executes completely over 8 separate executions at $77.15. At around 12:50:48, the trader places a second sale limit order for 100 shares at $77.12, which is executed immediately at $77.14.

trader is able to acquire a short position through the sale of shares at prices that appear to have been inflated by the Loud-side purchase orders.

34. In Exhibit 7b, the trader appears to cover his short position at an advantageous price by creating an artificial appearance of supply. The trader places multiple Loud-side sale orders in a short period of time, only one of which is executed.[27] These Loud-side sale orders appear to have successfully placed downward pressure on the stock price. Shortly after the Loud-side sale orders end, a Quiet-side purchase order executes, with the trader purchasing shares at a price lower than available before the Loop started.[28] The remaining Loud-side sale orders are then cancelled. In summary, this trader is able to close out of his short position through the purchase of shares at prices that appear to have been depressed by the Loud-side sale orders. Over these two back-to-back Loops the trader bought low and sold high.

Exhibit 7. Trading in CERN on November 1, 2012 by Trader 188_102S

2. Trading in Grupo Televisa on August 12, 2015

35. Exhibits 8a and 8b illustrate two consecutive Layering Loops identified in the Avalon Trade Data that involve trading in shares of Grupo Televisa ("TV") on August 12, 2015. In the first loop, the trader places multiple Loud-side sale orders consistent with creating an artificial appearance of supply, thereby placing downward pressure on the stock price and allowing him to purchase shares at an advantageous price. In the second loop, the trader sells his long position by placing multiple Loud-side purchase orders consistent with creating an

[27] Over the period from 12:50:52 to 12:51:09, the trader places 67 sale limit orders for 100 shares each at increasingly lower prices from $77.17 to $77.06.

[28] At around 12:51:00, the trader places a purchase limit order for 1,200 shares at $77.07, which is not executed and canceled at around 12:51:07. At around 12:51:10, the trader places a second purchase limit order for 1,200 shares at $77.10, which is executed completely over 11 separate executions at prices ranging from $77.06 to $77.09. These shares appear to have been sold short less than a minute earlier.

artificial appearance of demand, thereby placing upward pressure on the stock price and allowing him to sell the shares at an advantageous price.

36. In Exhibit 8a, the trader begins the Loop with no outstanding orders or shares, and first places two purchase limit orders.[29] The trader then places multiple sale orders in a short period of time.[30] These Loud-side sale orders appear to have successfully placed downward pressure on the stock price. Shortly after the Loud-side sale orders end, both purchase orders execute, with the trader purchasing shares at a price lower than available before the loop started.[31] The remaining Loud-side sale orders are cancelled around the same time. In summary, the trader is able to acquire a long position through the purchase of shares at prices that appear to have been depressed by the Loud-side sale orders.

37. In Exhibit 8b, the trader appears to sell his long position at an advantageous price by creating an artificial appearance of demand. The trader first places two sale limit orders, and then places multiple Loud-side purchase orders in a short period of time.[32] These Loud-side purchase orders appear to have successfully placed upward pressure on the stock price. Shortly after the Loud-side purchase orders end, both sale orders execute, with the trader selling shares at a price higher than available before the Loop started.[33] The remaining Loud-side purchase orders are cancelled at around the same time. In summary, this trader is able to

[29] At around 10:13:35, the trader places 2 purchase limit orders for 3,500 shares each at $32.37.

[30] At around 10:13:54, the trader places 12 sale limit orders for 1,000 to 3,000 shares each at increasingly lower prices from $32.40 to $32.38.

[31] At around 10:13:55, both purchase limit orders for 3,500 shares each are executed completely over 10 separate executions at $32.37.

[32] At around 10:14:08, the trader places 2 sale limit orders for 3,500 shares each at $32.43. At around 10:14:41, the trader places 12 purchase limit orders for 1,000 to 3,000 shares each at increasingly higher prices from $32.40 to $32.42.

[33] At around 10:14:42, both sale limit orders for 3,500 shares each are executed completely over 9 separate executions at $32.43.

sell his long position through the sale of shares at prices that appear to have been inflated by the Loud-side purchase orders. Over these two back-to-back Loops the trader bought low and sold high.

Exhibit 8. Trading in TV on August 12, 2015 by Trader 128_102S

D. Trading Revenues

38. To calculate Avalon's revenue from Layering Loops, I match purchases with sales. Avalon rarely carries any positions overnight (whether long or short), meaning that Avalon usually purchases and sells an equal number of shares each day for any given stock. My methodology matches purchases and sales as they occur in sequence; i.e., the first share purchased is matched to the first share sold, the tenth share purchased is matched to the tenth share sold, etc. I then define trading revenue for each matched purchase and sale as the difference between the purchase and sale prices.[34] Next, I aggregate the revenues (and losses) for each purchase and sale in Layering Loops. Aggregating these revenues (and losses) across all Layering Loops, I calculate total trading revenue of more than $21 million between December 2010 and September 2016. More than $12 million of this revenue is generated in 2015 and 2016.

39. The distribution of Avalon's trading revenue provides further evidence that its traders were engaged in a layering strategy. In a layering strategy, traders place non bona-fide orders that they typically do not want executed on the Loud-side, and place bona-fide orders that they do want executed on the Quiet-side. Therefore, traders may lose money on their

[34] Following mark-to-market convention, in the rare instance when the purchase and sale volume do not match for a day, the price for the other side of transaction is assumed to be the closing price that day. For example, if one day Avalon purchased 10,000 shares of Apple stock and sold 9,999 shares then the revenue on the 10,000th share bought would be the closing price minus the purchase price. Also note that where only one side of each matched transaction occurs during a Layering Loop, I attribute only half of the calculated trading revenue to that Layering Loop.

Loud-side executions, as these executions are typically unintentional, but make a significant amount of money on Quiet-side executions, which occur only after the market has moved favorably in the trader's direction.

40. By analyzing the average revenue per share in Avalon's executions, I find that, on average, Quiet-side executions in Layering Loops generate positive trading revenue of over $.0207 per share, while Loud-side executions in Layering Loops generate negative trading revenues of about $0.0006 per share. In 2015 and 2016, these differences are even greater. Quiet-side executions generate positive trading revenue of more than $.030 per share, while Loud-side executions generate losses of around $.003 cents per share. In other words, in 2015 and 2016 an execution for 100 shares makes about $3 on average if it occurs on the Quiet-side, but loses about $0.30 on average if it occurs on the Loud-side. As with the realized spread analysis in Section III.B.4, the positive trading revenues on Quiet-side executions and the negative trading revenues on Loud-side executions are consistent with Avalon impacting the market in order to execute its Quiet-side orders at a more favorable price than would have been available if it did not place Loud-side orders. Exhibit 9 summarizes the results of my analysis.

Exhibit 9. Equity Trading Revenue Analysis

41. I further examine Avalon's trading revenues to determine trading revenues relative to trading volume for Layering Loops versus Non-Layering Loops. Although large trading revenue is not by itself an indicator of layering activity, Layering Loops may be more profitable than non-manipulative strategies. Exhibit 10 summarizes the results of my findings. Specifically, I find that although less than 5% of Avalon's equities trading volume is in Layering Loops, the Layering Loops account for more than 45% of Avalon's total equities trading revenue. In 2015, layering made up just 4.4% of total equities trading volume and accounted for 106% of total equities trading revenue. This is because in 2015, Non-Layering

Loops were unprofitable and the positive equities trading revenue for the year was due entirely to layering activity. Layering Loops account for the vast majority of equities trading revenue in 2016 as well – while layering comprises 3.5% of equities trading volume, it accounts for 80% of total equities trading revenue. These results suggest that Avalon's Layering Loops generate almost all of their equities profits.

Exhibit 10. Equity Trading Revenue and Volume Analysis

E. Alternative Order and Execution Imbalance Ratios

42. The analyses in the preceding sections use an Order Imbalance of 2-to-1 and an Execution Imbalance of 3-to-1. To ensure that overall conclusions are not sensitive to these exact ratios, I perform the same analyses using three additional ratios for Order Imbalance (3-to-1, 5-to-1, and 10-to-1) and for two additional ratios for Execution Imbalance (5-to-1 and 10-to-1). This yields a total of 12 possible permutations of Order and Execution Imbalance ratios. As the Imbalance ratios become larger, the requirements are more stringent. The Loops with higher ratios are a subset of the Loops with lower ratios.

43. To confirm that the evidence of substantial activity in the Avalon Trade Data consistent with layering is robust to the choice of Order Imbalance and Execution Imbalance ratios, Exhibits 11 through 16 summarize the above analyses for all 12 permutations of Order Imbalance and Execution Imbalance ratios. As the Imbalance ratios become more stringent:

a. Exhibit 11 shows that cancellations of the Loud-side orders occur with similar promptness after the last Quiet-side execution or cancellation.

b. Exhibit 12 shows that a higher percentage of the long/short positions of the traders at the start of the Layering Loops are consistent with layering.

c. Exhibit 13 shows that the NBBO price movements are consistent with the Loud-side orders impacting the stock price to improve the Quiet-side executions.

d. Exhibits 14 and 15 show that Quiet-side executions are more profitable than Loud-side executions.

e. Exhibit 16 shows that trading revenues relative to trading volume are higher in Layering Loops than Non-Layering Loops.

44. Thus, the results of my analyses are not sensitive to the ratios for Order and Execution Imbalances.

Exhibit 11. Cancellation Analysis for Alternative Ratios: Time from Last Quiet-side Execution/Cancellation to All Loud-side Cancellations (Cumulative Percent of Layering Loops)

Exhibit 12. Position Analysis for Alternative Ratios: Starting Position Relative to Loud-side Orders

Exhibit 13. NBBO Movement Analysis for Alternative Ratios: Price Movement Relative to Loud-side Orders

Exhibit 14. Realized Spread Analysis for Alternative Ratios

Exhibit 15. Equity Trading Revenue Analysis for Alternative Ratios

Exhibit 16. Equity Trading Revenue and Volume Analysis for Alternative Ratios

IV. LAYERING'S IMPACT

A. Layering Can Create Uncertainty and Decrease Market liquidity

45. Layering can harm other traders and the market as a whole in several ways. First, limit orders that are not intended to execute can create false information, and increase uncertainty about true supply and demand. As most market makers are risk-averse, the

imbalances created by layering expose them to more risk.[35] As a result, market makers may quote a wider spread. As market orders arrive, the prices at which they execute will be worse. Such a reduction in market liquidity is a possible economic harm of layering. This can lead liquidity providers to place smaller orders and/or orders at inferior prices, and can also make it harder for other traders to fill their orders at desirable prices. This decreases market liquidity and increases trading costs for investors.[36]

B. Layering Can Increase the Difficulty of Executing Orders

46. Second, layering orders can cause other traders to execute marketable trades at prices that they would not have accepted had they known the true supply and demand. Market participants usually expect the existing bids and offers to reflect an unbiased estimate of supply and demand for stocks. When layering occurs, some market participants are likely to rely on false information when placing their orders. Because market prices can respond to artificial supply and demand, executions can occur at prices different from the prices that would prevail without the artificial supply and demand. Once the artificial supply or demand from layering is cancelled, market participants that traded at any artificial prices regret having done so and become more hesitant to trade in the future. For example, if a layering trader places a large volume of non-bona fide buy orders, another market participant would interpret it as an increasing buying interest in the market, and may place its purchase order at a higher price, resulting in an execution. Once the layering trader cancels his buy orders, the other market participant would find its purchase order executed at too high a price.

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[35] Terrence Hendershott and Albert Menkveld, "Price pressures," *Journal of Financial Economics* 114 (2015): 408-409.

[36] Douglas Cumming, Sofia Johan, and Dan Li, "Exchange trading rules and stock market liquidity," *Journal of Financial Economics* 99 (2011): 665 find that stock exchanges with rules prohibiting spoofing and layering have higher liquidity and lower trading costs.

C. Layering Can Degrade Market Integrity and Reduce Market Participation

47. Third, false information about supply and demand may degrade market integrity, as investors are less certain that they can observe accurate prices. In deciding whether to buy stocks, investors factor in the risk of being cheated.[37] Reduced trust in the market can lead to reduced participation (or complete withdrawal) by investors.[38] Lower market participation causes direct harm to the withdrawing investors, and indirect harm to all other investors (due to fewer investors with whom they can trade).[39] In an attempt to quantify the impact of reduced trust, the academic literature indicates that the lack of trust amplifies the effect of costly participation. In particular, if an investor thinks that there is a 2% probability that he will be cheated, the threshold level of wealth beyond which he invests in the stock market will increase fivefold.[40]

V. CONCLUSIONS

48. Based on my analysis of the Avalon Trade Data, from December 2010 through September 2016, Avalon conducted 675,506 Layering Loops, yielding trading revenue of more than $21 million. Furthermore, the differential execution rates of Loud-side and Quiet-side orders, prompt cancellation of Loud-side orders, the traders' positions when starting a Layering Loop relative to the Loud and Quiet sides, NBBO price movements relative to the Loud and Quiet sides, and the relative profitability of Loud-side and Quiet-side orders are all consistent

[37] Luigi Guiso, Paola Sapienza, and Luigi Zingales, "Trusting the Stock Market," *Journal of Finance* 63 (2008): 2557.

[38] See: Mariassunta Giannetti and Tracy Yue Wang, "Corporate Scandals and Household Stock Market Participation," *Journal of Finance* 71 (2016): 2628.

[39] Haim Mendelson, "Market behavior in a clearing house," *Econometrica* 50 (1982)*:*18.

[40] Luigi Guiso, Paola Sapienza and Luigi Zingales, "Trusting the Stock Market," *Journal of Finance* 63 (2008): 2558.

with a layering strategy. These patterns demonstrate that the Layering Loops I identify are unlikely to have arisen unintentionally and are not consistent with market making.

49. My work in this matter is ongoing, and I reserve the right to supplement this analysis in the future.

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